

PATENT COOPERATION TREATY

PCT

INTERNATIONAL PRELIMINARY EXAMINATION REPORT

(PCT Article 36 and Rule 70)

| | | |
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| Applicant's or agent's file reference 07640002WO | FOR FURTHER ACTION See Notification of Transmittal of International Preliminary Examination Report (Form PCT/IPEA/416) | |
| International application No. PCT/US04/04854 | International filing date (day/month/year) 20 February 2004 (20.02.2004) | Priority date (day/month/year) 21 February 2003 (21.02.2003) |
| International Patent Classification (IPC) or national classification and IPC IPC: G02B 5/32(2006.01);G02B 7/00(2006.01) USPC: 359/1,14,16,19,31,196.1;356/123,124,138,388,399;355/18,55,67,402,403 | | |
| Applicant NIKON PRECISION INC. | | |
| <p>1. This international preliminary examination report has been prepared by this International Preliminary Examining Authority and is transmitted to the applicant according to Article 36.</p> <p>2. This REPORT consists of a total of <u>10</u> sheets, including this cover sheet.</p> <p><input type="checkbox"/> This report is also accompanied by ANNEXES, i.e., sheets of the description, claims and/or drawings which have been amended and are the basis for this report and/or sheets containing rectifications made before this Authority (see Rule 70.16 and Section 607 of the Administrative Instructions under the PCT).</p> <p>These annexes consist of a total of ___ sheets.</p> <p>3. This report contains indications relating to the following items:</p> <p>I <input checked="" type="checkbox"/> Basis of the report</p> <p>II <input type="checkbox"/> Priority</p> <p>III <input checked="" type="checkbox"/> Non-establishment of report with regard to novelty, inventive step and industrial applicability</p> <p>IV <input type="checkbox"/> Lack of unity of invention</p> <p>V <input checked="" type="checkbox"/> Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement</p> <p>VI <input type="checkbox"/> Certain documents cited</p> <p>VII <input checked="" type="checkbox"/> Certain defects in the international application</p> <p>VIII <input checked="" type="checkbox"/> Certain observations on the international application</p> | | |
| Date of submission of the demand 17 September 2004 (17.09.2004) | Date of completion of this report 27 September 2010 (27.09.2010) | |
| Name and mailing address of the IPEA/US Mail Stop PCT, Attn: IPEA/ US Commissioner for Patents P.O. Box 1450 Alexandria, Virginia 22313-1450 Facsimile No. | Authorized officer Kamini Shah Telephone No. (571) 272-2279 | |

Form PCT/IPEA/409 (cover sheet)(July 1998)

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I. Basis of the report

1. With regard to the elements of the international application:*

- ☒ the international application as originally filed.
- ☒ the description:
 pages 1-55 as originally filed
 pages NONE, filed with the demand
 pages NONE, filed with the letter of _____.
- ☒ the claims:
 pages 56-66, as originally filed
 pages NONE, as amended (together with any statement) under Article 19
 pages NONE, filed with the demand
 pages NONE, filed with the letter of _____.
- ☒ the drawings:
 pages 1-29, as originally filed
 pages NONE, filed with the demand
 pages NONE, filed with the letter of _____.
- ☐ the sequence listing part of the description:
 pages NONE, as originally filed
 pages NONE, filed with the demand
 pages NONE, filed with the letter of _____.

2. With regard to the **language**, all the elements marked above were available or furnished to this Authority in the language in which the international application was filed, unless otherwise indicated under this item.

These elements were available or furnished to this Authority in the following language _____ which is:

- ☐ the language of a translation furnished for the purposes of international search (under Rule 23.1(b)).
- ☐ the language of publication of the international application (under Rule 48.3(b)).
- ☐ the language of the translation furnished for the purposes of international preliminary examination (under Rules 55.2 and/or 55.3).

3. With regard to any **nucleotide and/or amino acid sequence** disclosed in the international application, the international preliminary examination was carried out on the basis of the sequence listing:

- ☐ contained in the international application in printed form.
- ☐ filed together with the international application in computer readable form.
- ☐ furnished subsequently to this Authority in written form.
- ☐ furnished subsequently to this Authority in computer readable form.
- ☐ The statement that the subsequently furnished written sequence listing does not go beyond the disclosure in the international application as filed has been furnished.
- ☐ The statement that the information recorded in computer readable form is identical to the written sequence listing

has been furnished.

4. ☐ The amendments have resulted in the cancellation of:

- ☐ the description, pages NONE
- ☐ the claims, Nos. NONE
- ☐ the drawings, sheets/fig NONE

5. ☐ This report has been established as if (some of) the amendments had not been made, since they have been considered to go beyond the disclosure as filed, as indicated in the Supplemental Box (Rule 70.2(c)).**

* Replacement sheets which have been furnished to the receiving Office in response to an invitation under Article 14 are referred to in this report as "originally filed" and are not annexed to this report since they do not contain amendments (Rules 70.16 and 70.17).

** Any replacement sheet containing such amendments must be referred to under item 1 and annexed to this report.

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III. Non-establishment of opinion with regard to novelty, inventive step and industrial applicability

1. The question whether the claimed invention appears to be novel, to involve an inventive step (to be non-obvious), or to be industrially applicable have not been and will not be examined in respect of:

- ☐ the entire international application,
☒ claims Nos. 44, 45, 47, and 48

because:

- ☒ the said international application, or the said claim Nos. 44, 45, 47 and 48 relate to the following subject matter which does not require international preliminary examination (*specify*):

Please See Continuation Sheet

- ☐ the description, claims or drawings (*indicate particular elements below*) or said claims Nos. ____ are so unclear that no meaningful opinion could be formed (*specify*):

- ☐ the claims, or said claims Nos. ____ are so inadequately supported by the description that no meaningful opinion could be formed.
☐ no international search report has been established for said claims Nos. ____

2. A meaningful international preliminary examination cannot be carried out due to the failure of the nucleotide and/or amino acid sequence listing to comply with the standard provided for in Annex C of the Administrative Instructions:

- ☐ the written form has not been furnished or does not comply with the standard.
☐ the computer readable form has not been furnished or does not comply with the standard.

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PCT/US04/04854**V. Reasoned statement under Rule 66.2(a)(ii) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement****1. STATEMENT**

| | | |
|-------------------------------|----------------------------|-----|
| Novelty (N) | Claims <u>NONE</u> | YES |
| | Claims <u>1-43, and 46</u> | NO |
| Inventive Step (IS) | Claims <u>NONE</u> | YES |
| | Claims <u>1-43, and 46</u> | NO |
| Industrial Applicability (IA) | Claims <u>1-43, and 46</u> | YES |
| | Claims <u>NONE</u> | NO |

2. CITATIONS AND EXPLANATIONS

Please See Continuation Sheet

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VII. Certain defects in the international application

The following defects in the form or contents of the international application have been noted:

Claims 43, and 48 needs a period.

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VIII. Certain observations on the international application

The following observations on the clarity of the claims, description, and drawings or on the questions whether the claims are fully supported by the description, are made:

- a. For example, claims 1, 42, 46, and 48 recite "specified aberration values". It is unclear where this "specified aberration values" comes from? Is "aberration components" and "aberration values" similar?
 - b. As per claim 2, it is unclear what does adjustment "goodness" mean? Further, the language "steps are used" seems an intended use.
 - c. As per claim 15, it is unclear how the evaluating step "eliminates the need for full simulation"?
 - d. As per claim 22, the language "leads to" seems an intended use.
 - e. Claim 47 recites "code for adjusting a lens". It is impossible a "code" by itself to do the steps. A "code" could instruct a computer to execute the steps or processes. Therefore, the preamble should be amended to reflect the code or program instructs the computer to do/execute the steps or processes.
 - f. As per claims 43, and 48, the claims recite "defined criteria". It is unclear what "criteria" referring too. Further, the claim recites "judges", which is vague and indefinite. It could raise many questions such as how the judgment done. Is it human judgment? Therefore, it needs to substitute "judges" with appropriate word.
- Claims 44, and 45 provide for the use of the exposure apparatus of claim 42, but, since the claim does not set forth any steps involved in the method/process, it is unclear what method/process applicant is intending to encompass. A claim is indefinite where it merely recites a use without any active, positive steps delimiting how this use is actually practiced.

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(To be used when the space in any of the preceding boxes is not sufficient)

Section III. Non-establishment of report (subject matter not requiring preliminary examination)

Regarding claims 44, and 45, the claimed invention does not fall within at least one of the four categories of patent eligible subject matter recited in 35 U.S.C. 101 (process, machine, manufacture, or composition of matter).

Regarding claims 47, and 48, claims are rejected under 35 U.S.C. 101 because the claimed invention is directed to non-statutory subject matter. For example, claim 47 recites a "machine readable medium". The specification does not provide antecedent basis for the claim terminology "machine readable medium". Therefore, the context the medium used in the claim would fairly suggest to one of ordinary skill as signals or other forms of propagation and transmission media, typewritten or handwritten text on paper, or other items failing to be an appropriate manufacture under 35 USC 101 in the context of computer-related inventions. Therefore, for this matter, the claims are non statutory. Because the "machine readable medium" of claims 47 and 48 are not limited to tangible mediums as stated above, the claims as whole are software per se resides in non-tangible medium.

V. 2. Citations and Explanations:

Claim 1 lacks novelty under PCT article 33(2) as being anticipated by Nakashima et al discloses a method of calculating estimated image profiles (such as...*imaging performance*...; See: Abstract), comprising the steps of:
 providing imaging configuration characteristic data (such as *lithographic performances named linewidth abnormality (LWA) and best focus shift (BFS)*...; See: page 33, "2. Zernike Sensitivity Method", paragraph one);
 performing simulation calculations for various levels of aberration components using the imaging configuration characteristic data (such as*simulation assumption of two lithographic performance named linewidth abnormality (LWA) and best focus shift (BFS)*...(see: page 33, "2. Zernike Sensitivity Method" paragraph two and also tables 1, and 2)....*conduct aerial image calculation of LWA or BFS*...(See: page 34 lines 1-2));
 building response surface functional relations between variables of lens characteristics and an image profile of interest using the simulation calculations (such as...*LWA and BFS sensitivities to Zernike components for the set of conditions listed in Table 1 and 2*...; See: page 34, lines 1-6); and

evaluating specified aberration values of a lens in relation to the response surface functional relations to provide an estimate of the image profile in a presence of specified aberration(s) (such as ...*compare the ZSM prediction to the exact aerial image simulation of a given lithographic metric*...;See: page 34, lines 12-17).

Claim 2 lacks novelty under PCT article 33(2) as being anticipated by Nakashima et al discloses the method of claim 1, ~~wherein the image profiles which result as part of the evaluating step are used as measures of relative lens adjustment goodness in an~~
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(To be used when the space in any of the preceding boxes is not sufficient)

iterative lens adjustment optimization routine (See; page 37 lines 5-12).

Claim 3 lacks novelty under PCT article 33(2) as being anticipated by Nakashima et al discloses the method of claim 1, wherein the imaging configuration characteristic data includes lens data, illumination data and pattern data (See for example the simulation conditions of table 3 includes lens data, illumination data and pattern data and also see Figs. 15 and 16).

Claim 4 lacks novelty under PCT article 33(2) as being anticipated by Nakashima et al discloses the method of claim 3, wherein: the illumination data includes at least one of illumination distribution and illumination wavelength, the lens data includes at least one of lens aberration, numerical aperture, pupil filters and lens configuration; and the pattern data includes object (reticle pattern) layout (See for example the simulation conditions of table 3 includes lens data, illumination data and pattern data and also see Figs. 15 and 16).

Claim 5 lacks novelty under PCT article 33(2) as being anticipated by Nakashima et al discloses the method of claim 4, wherein the imaging configuration characteristic data further includes at least one of pattern bias characteristic information and lens focus (such as*simulation assumption of two lithographic performance named linewidth abnormality (LWA) and best focus shift (BFS)*... (see: page 33, "2. Zernike Sensitivity Method" paragraph two and also tables 1, and 2).

Claim 6 lacks novelty under PCT article 33(2) as being anticipated by Nakashima et al discloses the method of claim 1, wherein the simulation calculations are executed for various levels of each aberration component (See: page 34 lines 1-6 for example *Zernike*

components such as Odd- θ components...and even- θ components for LWA and BFS).

Claim 7 lacks novelty under PCT article 33(2) as being anticipated by Nakashima et al discloses the method of claim 1, further comprising the step of generating a new set of aberration component impact upon image profile fitted coefficients values using the response surface functional relations each time a new set of input aberration components is presented for image profile calculation (such as ...*calculation modify the CD-Focus curve by deltaFocus and deltaCD shifts representing the impact of aberration on the CD-Focus curve...*; See: page 36, "3.4 CD predictions" lines 1-6).

Claim 8 lacks novelty under PCT article 33(2) as being anticipated by Nakashima et al discloses the method of claim 1, further comprising the step of generating a new set of aberration components impact upon image profile coefficient values using interpolative methods using the response surface functional relations (such as ...*calculation modify the CD-Focus curve by deltaFocus and deltaCD shifts representing the impact of aberration on the CD-Focus curve...*; See: page 36, "3.4 CD predictions" lines 1-6).

Claim 9 lacks novelty under PCT article 33(2) as being anticipated by Nakashima et al discloses the method of claim 1, wherein the response surface functional relations correspond to a sample set of lens characteristics with a final output from application of response surface functional relations being an image profile under the influence of lens aberrations (See: page 34, lines 1-6).

Claim 10 lacks novelty under PCT article 33(2) as being anticipated by Nakashima et al discloses the method of claim 9, wherein the data configuration characteristic information includes lens characteristics related to variation in single aberration values alone or in combination with one another or with selected items from among the lens characteristics (See: page 35 lines 11-19).

Claim 11 lacks novelty under PCT article 33(2) as being anticipated by Nakashima et al discloses the method of claim 1, wherein the response surface functional relations are related to a look-up table summarizing the results of interpolating the image profile generated by the simulation calculations of the performing step (See: Table 5).

Claim 12 lacks novelty under PCT article 33(2) as being anticipated by Nakashima et al discloses the method of claim 11, wherein the look-up table is direct simulation image profile results or of functional coefficients used to calculate the image profile (See: Table 5).

Claim 13 lacks novelty under PCT article 33(2) as being anticipated by Nakashima et al discloses the method of claim 11, wherein the evaluating step includes determining image profile data points using the look-up table to provide a new image profile associated with specified aberration values (such as *the impact of Z9 before and after adjustment...* See: Figs. 19 and 20).

Claim 14 lacks novelty under PCT article 33(2) as being anticipated by Nakashima et al discloses the method of claim 1, wherein the evaluating step includes applying interpolated data (such as ...*CD-Focus curve*) of the built response surface functional relations to calculate the image profile for specified aberration values (such as ...*calculation modify the CD-Focus curve by deltaFocus and deltaCD shifts representing the impact of aberration on the CD-Focus curve...*; See: page 36, "3.4 CD predictions" lines 1-6).

Claim 15 lacks novelty under PCT article 33(2) as being anticipated by Nakashima et al discloses the method of claim 1, wherein the evaluating step eliminates the need for a full simulation calculation each and every time new specified aberration values are provided and presented for calculation of a new image profile (such as ...*adjusting only Z9 on the aberration content...*; See: Figs. 18-20 and corresponding texts).

Claim 16 lacks novelty under PCT article 33(2) as being anticipated by Nakashima et al discloses the method of claim 1, wherein the building steps includes providing a fitting function (such as ...*calculate without aberration...calculate the delta Focus and deltaCD dependencies on aberrationdeltaCD obtained through quadratic Zernike Sensitivity method (i.e. fitting function)...*; See: page 34, "3.1 Procedure" lines 1-6).

Claim 17 lacks novelty under PCT article 33(2) as being anticipated by Nakashima et al discloses the method of claim 16, wherein the fit coefficient are generated from a single aberration polynomial coefficient or from at least one of multiplication division of one aberration polynomial coefficient by another (such as ...*Quadratic ZSM and also see equation 1 and 2 of page 34*).

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(To be used when the space in any of the preceding boxes is not sufficient)

Claim 18 lacks novelty under PCT article 33(2) as being anticipated by Nakashima et al discloses the method of claim 16, wherein the coefficient are stored for each simulation calculation following their determination via fitting to the simulation calculation of the performing step (such as ...*Quadratic ZSM and also see equation 1 and 2 of page 34*).

Claim 19 lacks novelty under PCT article 33(2) as being anticipated by Nakashima et al discloses the method of claim 16, wherein $n=4$ (See: equation 1, and 2).

Claim 20 lacks novelty under PCT article 33(2) as being anticipated by Nakashima et al discloses the method of claim 16, wherein $Z_n=37$ (See: Equation 1, and 2).

Claim 21 lacks novelty under PCT article 33(2) as being anticipated by Nakashima et al discloses the method of claim 1, wherein each different aberration value applied during the performing step leads to one full image simulation calculation (See: page 34, lines 1-6).

Claim 22 lacks novelty under PCT article 33(2) as being anticipated by Nakashima et al discloses the method of claim 1, wherein the evaluating step provides one output image profile for each one set of specified input aberration values (See: page 34, lines 5-6).

Claim 23 lacks novelty under PCT article 33(2) as being anticipated by Nakashima et al discloses the method of claim 1, wherein the response surface function relations are built relating any of variables: (i) position within a specified image plane, (ii) intensity or amplitude, (iii) focus, and (iv) all component aberration levels (such as ...*focus and all component aberration levels...*; See: page 34 lines 1-6).

Claim 24 lacks novelty under PCT article 33(2) as being anticipated by Nakashima et al discloses the method of claim 1, wherein the performing step includes the steps of: defining a simulation pixel as a unit of horizontal or vertical, position into which an aerial image is divided; calculating aerial image amplitude or intensity on each simulation pixel; and executing the calculations at defocus positions to provide image profile data including focus response (See: Figs. 19 and 20 and corresponding texts).

Claim 25 lacks novelty under PCT article 33(2) as being anticipated by Nakashima et al discloses the method of claim 1, wherein the evaluating step includes summing an impact from all specified aberration values or combinations of values defined as aberration coefficients for image profile reconstruction (such as *the impact of Z9 before and after adjustment...* See: Figs. 19 and 20).

Claim 26 lacks novelty under PCT article 33(2) as being anticipated by Nakashima et al discloses the method of claim 25, wherein the summing step provides an output of intensity or amplitude vs. at least one of position and focus for the specified aberration values which are an arbitrary set of aberration values (See: Fig. 18).

Claim 27 lacks novelty under PCT article 33(2) as being anticipated by Nakashima et al discloses the method of claim 1, wherein the evaluating step is performed using a linear equation using fixed functions with coefficients determined in the building step (such as *quadratic fitting function*).

Claim 30 lacks novelty under PCT article 33(2) as being anticipated by Nakashima et al discloses a method of calculating estimated image profiles, comprising the steps of:

performing simulation calculations for various levels of aberration components using image configuration characteristic data (such as ...*simulation assumption of two lithographic performance named linewidth abnormality (LWA) and best focus shift (BFS)*... (see: page 33, "2. Zernike Sensitivity Method" paragraph two and also tables 1, and 2)...*conduct aerial image calculation of LWA or BFS*... (See: page 34 lines 1-2));

building response surface functional relations between variables of the image configuration characteristics and the image profile of interest using the simulation calculations (such as...*LWA and BFS sensitivities to Zernike components for the set of conditions listed in Table 1 and 2...*; See: page 34, lines 1-6) as data input to be fit (such as ...*conduct aerial image calculation of LWA or BFS*... (See: page 34 lines 1-2)...*calculate without aberration... calculate the delta Focus and deltaCD dependencies on aberration ... deltaCD obtained through quadratic Zernike Sensitivity method (i.e. fitting function)*...; See: page 34, "3.1 Procedure" lines 1-6) using:

summing an impact from at least one of all new specified aberration coefficients and combinations of aberration coefficients from the built response surface functional relations to provide lens adjustment data (See: page 37 lines 5-12).

Claims 31-41, the instant claims recite substantially same limitation as the above rejected claims 3, 4, 6-8, 18-20, 23, 24, 26, and therefore rejected under the same rationale.

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(To be used when the space in any of the preceding boxes is not sufficient)

Claim 46 lacks novelty under PCT article 33(2) as being anticipated by Nakashima et al discloses a system for providing optimal image profiles through the optimization of specified aberration components, according to their associated impact upon image profile, comprising:

means for performing simulation calculations for various levels of aberration components using characteristic data; means for building response surface functional relations between variables of lens characteristics using the simulation calculations (such as*simulation assumption of two lithographic performance named linewidth abnormality (LWA) and best focus shift (BFS)*...) (see: page 33, "2. Zernike Sensitivity Method" paragraph two and also tables 1, and 2)....*conduct aerial image calculation of LWA or BFS*...(See: page 34 lines 1-2));

means for evaluating specified aberration values of a lens in relation to the response surface functional relations to provide image profile estimates for the specified aberration values (such as ...*compare the ZSM prediction to the exact aerial image simulation of a given lithographic metric*...; See: page 34, lines 12-17); and

means for applying the aberrated image profile estimates in an optimization calculation method which judges image profile information against defined criteria as part of a lens adjustment optimization calculation (See: page 37 lines 5-12).

Claim 28 lacks an inventive step under PCT Article 33(3) as being obvious over Nakashima et al in view of Official Notice. Nakashima et al clearly teaches the building and evaluating steps using quadratic fitting function. However, he did not explicitly state a sinusoidal fitting function. Official notice is taken that it was known at the time of the invention to implement the building and evaluating steps using a sinusoidal fitting function. This implementation would have been obvious because one of ordinary skill in the art would be motivated to change quadratic Zernike fitting function to sinusoidal fitting functions using well known trigonometric functions.

Claim 29, the same Official Notice will apply as claim 28.

Claim 42 lacks an inventive step under PCT Article 33(3) as being obvious over Nakashima et al in view of Shiode et al, Nakashima et al discloses an exposure apparatus, comprising:

a system for providing optimal image profiling (such as *aerial image simulation*), including:

means for providing image configuration characteristic data;

means for performing simulation calculations for various levels of aberration components using the image configuration characteristic data (such as*simulation assumption of two lithographic performance named linewidth abnormality (LWA) and best focus shift (BFS)*...) (see: page 33, "2. Zernike Sensitivity Method" paragraph two and also tables 1, and 2)....*conduct aerial image calculation of LWA or BFS*...(See: page 34 lines 1-2));

means for building response surface functional relations between variables of lens characteristics associated with the image configuration characteristic data using the simulation calculations (such as...*LWA and BFS sensitivities to Zernike components for the set of conditions listed in Table 1 and 2*...; See: page 34, lines 1-6); and

means for evaluating specified aberration values of a lens in relation to the response surface functional relations to provide image profile estimates for the specified aberration values (such as ...*compare the ZSM prediction to the exact aerial image simulation of a given lithographic metric*...; See: page 34, lines 12-17).

Nakashima et al fails expressly to disclose an illumination system that projects radiant energy through a mask pattern on a reticle R that is supported by and scanned using a wafer positioning stage; and at least one linear motor that position the wafer positioning stage.

Shiode et al disclose an illumination system that projects radiant energy through a mask pattern on a reticle R that is supported by and scanned using a wafer positioning stage (See: Fig. 1 for example, illumination aperture and Reticle and Wafer); and at least one linear motor that position the wafer positioning stage (See: Fig 1 the rotation of Illumination aperture).

It would have been obvious to one of ordinary skill in the art to modify the teachings of Nakashima et al with the teachings of Shiode et al to produce different displacement values and angles.

Claim 43 lacks an inventive step under PCT Article 33(3) as being obvious over Nakashima et al in view of Shiode et al, Nakashima et al discloses the apparatus of claim 42, further comprising means for applying the aberrated image profile estimates in an optimization calculation method which judges image profile information against defined criteria as part of a lens adjustment optimization calculation (See: page 37 lines 5-12).

Claims 1-43, and 46 meet the criteria set out in PCT Article 33(4), and thus have industrial applicability because the subject matter claimed can be made or used in industry.